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Attention: Box PCT - DESIGNATED/ELECTED OFFICE (DO/EO/US)

FORM PTO-1390 (REV 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER **31440-174181**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
INTERNATIONAL APPLICATION NO. **PCT/EP00/10559**	INTERNATIONAL FILING DATE **October 26, 2000**	PRIORITY DATES CLAIMED **October 29, 1999**
TITLE OF INVENTION - see attached pages -		
APPLICANT(S) FOR DO/EO/US - see attached pages -		

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(l).

- See attached pages for additional data -

APPARATUS FOR SUPPLYING CURRENT TO AUXILIARY DEVICES IN RAIL VEHICLES

[1] The invention relates to an apparatus for supplying current to auxiliary devices, such as control, indicator, lighting and display devices or the like, in rail vehicles, particularly high-speed vehicles, regional-railway vehicles, street cars and local trains, in which a separate current-supply device assumes the task of supplying current to the auxiliary devices.

[2] Up to now, the supply of electrical consumers in rail vehicles when the main power supply is cut off has been effected by lead accumulators that assure proper lighting in the passenger compartment, and supply current for signal lighting, train-target indicators and other electrical consumers, such as ventilators, for a specified period. These lead accumulators are located, with the fuses and the charge device, in a box-shaped battery module mounted to the undercarriage of each car. This module is very heavy, and correspondingly reduces the traction capability of the driving aggregate, particularly in vehicles having internal-combustion engines. Performance is reduced by the consumption of power by the auxiliary

devices and the mass inertia of the module when the vehicle accelerates.

[3] Furthermore, lead accumulators require continuous checks, maintenance and care. After being expended, lead accumulators are considered hazardous waste, and are harmful to the environment.

[4] During operation, lighting machines or generators are used to supply consumers with power. These consumers include components of the brake or shock-absorption system, the electrical or pneumatic windshield wipers, the electrical or pneumatic door drives, pantograph actuators, and/or car lift mechanisms that may be provided.

[5] This setup is associated with a high weight and a low efficiency. If the drive aggregate supplies the power for a lighting machine or generator, its traction capability is reduced. In the case of a separate drive aggregate for a lighting machine or generator, for example of an auxiliary diesel engine, this solution is associated with considerable additional costs for the separate drive. Moreover, all of these solutions incur additional costs for power adaptation and transmission. The systems are relatively costly to maintain.

[6] It is known to use fuel cells on a methanol base

[7] for stationary and mobile current supply, e.g., for road vehicles (ÖZE 40, 3(1987) and the 1996 Daimler Benz prospectus, "A Methanol Car Hits the Roads"). The fuel cells supply a cell voltage of about 0.6 V, so a plurality of cells must be connected one behind the other to attain the necessary drive power.

[8] DE 197 03 171 A1 describes a road vehicle having a driving internal-combustion engine or a fuel-cell drive system. A fuel-cell aggregate supplies on-board network consumers independently of the drive system.

[9] DE 196 17 978 A1 discloses an electrically-operated rail vehicle having a fuel-cell drive. It is also known to use fuel cells as the drive for road vehicles: refer to Krafthand, Vol. 15, 8/9/97: "Stellt die Brennstoffzelle den Fahrzeugantrieb der Zukunft dar? [Does the Fuel Cell Represent the Vehicle Drive of the Future?]" Here, PEM fuel cells are used as the current supply source for electric motors.

[10] DE 196 41 254 A1 discloses a road vehicle having an electrical drive. DE 197 55 815 A1 describes a method for operating a system for steam reforming of a hydrocarbon, and a reforming system operated therewith, particularly for use in a fuel-cell-operated road vehicle.

DE 198 17 534 A1 describes a method and a system for generating electrical power with the use of a PEM fuel cell, while DE 197 01 560 C2 discloses a fuel-cell system having a PEM fuel cell.

[11] Typically, rail vehicles require very complicated technical equipment for supplying auxiliary power; such equipment possesses other technical features, characteristics and functions than those of a motor vehicle. This relates to the significantly higher power requirement of the auxiliary devices of these vehicles in comparison to a motor vehicle. Also, different voltage potentials are often required in rail vehicles.

[12] In view of the prior art, it is the object of the invention to provide a second current supply, particularly the current supply of control, indicator, lighting and display devices and the like, that can be operated independently of the drive system in rail vehicles, has a low weight and is easier to maintain and more environmentally-friendly.

[13] This object is accomplished by an apparatus of the generic type mentioned at the outset and having the features of claim 1. The dependent claims disclose advantageous embodiments.

[14] In accordance with the invention, it is proposed to couple out all, or at least part, of the auxiliary power required for a rail vehicle, particularly for consumers at different voltage potentials, as well as for brake or shock-absorption systems, electrical or pneumatic windshield wipers, electrical or pneumatic door drives, pantograph actuators and/or car lift equipment, from the primary power source.

[15] The apparatus in accordance with the invention permits the use of fuel-cell technology, for example on a methanol base, in rail vehicles, and the supply of current independently of the primary drive. The elimination of the battery module dramatically reduces the weight of the current supply. In addition, especially in diesel or auxiliary-diesel rail vehicles, the apparatus eliminates standard lighting machines or generators that convert power supplied by the primary or auxiliary drive into electrical power. The entire auxiliary diesel is eliminated from these rail vehicles.

[16] The necessary adaptation systems and electronic controls, such as the on-board-network inverter, are no longer needed. In electrically-operated rail vehicles, for

example, main transformer auxiliary windings and on-board-network converters are omitted.

[17] The direct conversion of chemical energy into electrical energy in the fuel cells is more efficient than a process involving mechanical energy as an intermediate stage. This means that less power need be supplied for the current supply of the auxiliary devices, and the total power of the main drive is available for traction.

[18] Costly maintenance of the battery module for each car is no longer necessary.

[19] In accordance with the invention, it isadditionally possible to effect a decentralized current supply instead of a central, engine-based current supply. In engine-based current-supply systems, the current supply must be set up for the maximum necessary power, regardless of the number of train cars. Decentralized systems lead to an adaptation of the power of the current supply to the respective needs. Thus, a plurality of current supplies can be disposed in at least two parts of a train, notably each car. This also reduces the weight of the current-supply system. A further advantage is the simplification of the transfer of power from the current-supply system to the consumer; in

particular, the transfer of electrical power over the entire length of a train is avoided.

[20] The invention is described in detail below by way of an exemplary embodiment illustrated in the drawings. Shown are in:

[21] Fig. 1 the fundamental structure of the arrangement in accordance with the invention;

[22] Fig. 2 a detail X in accordance with Fig. 1; and

[23] Fig. 3 a variation of the integration of the arrangement according to the invention into the on-board network of a rail vehicle.

[24] Fig. 1 illustrates the basic design of the arrangement of a fuel-cell aggregate 1 according to the invention, which is integrated in a compact manner into the car construction of a rail vehicle, not shown.

[25] A tank 2 is filled with methanol, as the primary energy carrier, using a conventional tank-filling technique. The tank 3 is provided for receiving the deionized water or reaction water. As shown in Fig. 1, the deionized water is mixed with the methanol and evaporated in an evaporator 4. Upon being heated to about 250°C by a catalytic burner 5 in the reformer 6, this methanol-steam is split into hydrogen, carbon dioxide and residual gases

such as carbon monoxide, etc. The subsequent gas-purification device 7 separates the hydrogen from the carbon dioxide and the residual gases. The hydrogen obtained in this manner is carried off to the fuel cell 8, and the carbon dioxide escapes into the atmosphere.

[26] The fuel cell 8 itself essentially comprises a proton-exchange membrane (PEM) 9 as an electrolyte; the membrane is provided on both sides with a platinum coating 10, an electrode 11 and cooling/bipolar elements 12 having gas conduits (Fig. 2).

[27] When the hydrogen passes through the membrane 9, the hydrogen molecule gives up its electrons under the effect of the catalytic platinum coating 10 at the anode; the electrons then flow to the consumer via the outer current circuit. At the same time, the air flow conveyed by the compressor 13 is supplied to the membrane 9, which reduces the oxygen contained in the air flow at the cathode. The oxygen molecules react with the hydrogen ions migrating through the membrane 9 and the electrons coming from the consumer to form water. A voltage of 0.6 V results for each fuel cell. The higher voltages that are required for supplying current to the auxiliary devices installed in

rail vehicles can easily be attained through the joining of numerous such cells into a package.

[28] A cooling pump 14 integrated into a cooling loop K conveys cooling air into the gas conduits of the bipolar element 12 of the fuel cell 8. The reaction heat formed in the reaction is combined with the cooling air, which in turn gives off this heat to a cooler 15 through a heat exchange. The water formed in the reaction passes into the water tank 3 via a supply line 16.

[29] Because there is not a 100% conversion of the hydrogen with the oxygen in the reaction in the fuel cell 8, a residual gas is formed and supplied to the catalytic burner 5 through a branch line 18. In the event that the calorific value of the residual gas does not suffice for operating the burner 5, methanol is additionally drawn from the tank 2 and burned in the burner 5 for maintaining the necessary reaction temperature for the conversion of the water-methanol steam.

[30] Fig. 3 schematically depicts the adaption of the arrangement according to the invention into the on-board network B_N of a rail vehicle. On the output side, the fuel-cell aggregate 7 is connected to a voltage adaptation 17,

with which the voltages required for the individual consumers V_1, V_2, V_n are set.

[31] Of course, the PEM fuel cells (Proton-Exchange Membrane Fuel Cell - PEMFC) used in the exemplary embodiment can also be replaced by other fuel cells, such as alkaline fuel cells (AFC), direct-methanol fuel cells (DMFC), molten-carbonate fuel cells (MCFC), phosphoric-acid fuel cells (PAFC), solid-oxide fuel cells (SOFC) or a combination of such fuel cells, including the corresponding devices for supplying the primary energy carrier for the fuel cell.

LIST OF REFERENCE CHARACTERS

1	Fuel-cell aggregate	B_N	On-board network
2	Methanol tank	K	Cooling loop
3	Water tank	V_1, V_2, V_n	Consumers
4	Evaporator		
5	Catalytic burner		
6	Reformer		
7	Gas-purification device		
8	Individual fuel cell		
9	Proton-exchange membrane (PEM)		
10	Platinum coating		
11	Electrode		
12	Cooling/bipolar element		
13	Compressor		
14	Cooling pump		
15	Cooler		
16	Supply line		
17	Voltage adaptation		
18	Residual-gas pipeline		

CLAIMS

1. An apparatus for supplying current to auxiliary devices in rail vehicles, characterized by a fuel-cell aggregate that is used independently of and decoupled from a primary power source.

2. The apparatus according to claim 1, characterized in that the fuel-cell aggregate is used for supplying current to auxiliary devices in the event of a current-supply cutoff.

3. The apparatus according to claim 1 or 2, characterized in that the fuel-cell aggregate is operated with methanol as the primary energy carrier.

4. The apparatus according to one of claims 1 through 3, characterized in that different types of fuel cells, such as proton-exchange membrane fuel cells (PEMFC), alkaline fuel cells (AFC), direct-methanol fuel cells (DMFC), molten-carbonate fuel cells (MCFC), phosphoric-acid fuel cells (PAFC), solid-oxide fuel cells (SOFC) or a combination of such fuel cells, including the corresponding

devices for supplying with the primary energy carrier for the fuel cell, can be used.

5. The apparatus according to one of claims 1 through 4, characterized by the use of proton-conducting electrolyte-membrane (PEM) fuel cells that are connected one behind the other in the fuel-cell aggregate.

6. The apparatus according to one of claims 1 through 5, characterized in that the current-supply device comprises a tank (3) for deionized water; a tank (2) for methanol; an evaporator (4) for mixing the water and methanol; a reformer (6) for converting the methanol into hydrogen and carbon dioxide; a gas-purification device (7) for removing the carbon monoxide and other undesirable gas components; a plurality of joined, proton-conducting electrolyte-membrane (PEM) fuel cells (8), in which the hydrogen, as a fuel, is continuously supplied and carried away with air that is compressed by a compressor (14) and serves as an oxidation means; a cooling loop (K) for cooling the fuel cells (8); a line (16) that carries off the reaction water and discharges into the tank (3); and a line (18) that carries off the residual gas resulting from

the reaction in the fuel cell and is connected to a catalytic burner (5) upstream of the reformer (6).

7. The apparatus according to claim 5 or 6, characterized in that the PEM fuel cell (8) comprises a package consisting of an end-side cooling/bipolar element (12) having integrated gas conduits, a membrane (9) that is coated on both sides with platinum, as a catalyst, an electrode (11) that is respectively associated with each side of the membrane, and a further end-side cooling/bipolar element (12).

8. The apparatus according to claim 7, characterized in that the package can be plugged together.

9. The apparatus according to one of claims 1 through 8, characterized in that the auxiliary devices include control, indicator, lighting and/or display devices.

10. The apparatus according to one of claims 1 through 9, characterized in that the rail vehicles include railway vehicles, streetcars or local trains.

11. The apparatus according to one of claims 1 through 10, characterized in that the primary power source of the rail vehicles is diesel- and/or electrically-operated.

12. The apparatus according to one of claims 1 through 11, characterized in that the current-supply device supplies at least components of the auxiliary mechanisms with electrical power, particularly the brake system, the shock-absorption system, the electrical or pneumatic windshield wipers, the electrical or pneumatic door drives, the pantograph actuators and/or the car lift mechanisms.

13. The apparatus according to one of claims 1 through 12, characterized in that the current supply can be located in decentralized fashion at two or more locations within a train.

14. The apparatus according to claim 13, characterized in that each train car has a current-supply apparatus, particularly for car-specific consumers.

15. The use of a fuel-cell aggregate to supply current to auxiliary devices, such as control, indicator, lighting and display devices or the like in rail vehicles, particularly railway vehicles, streetcars and local trains, in which a separate current-supply device assumes the task of supplying current to the auxiliary devices.

ABSTRACT

The object of the invention is to supply current to control, indicator, lighting and display devices or the like in rail vehicles, independently of the drive system, while reducing the weight and making the apparatus easier to maintain and more environmentally-friendly.

This object is accomplished in that a fuel-cell aggregate is used as a current-supply device. This aggregate, which processes methanol, comprises a tank 3 for deionized water; a tank 2 for methanol; an evaporator 4 for mixing the water and methanol; a reformer 6 for converting the methanol into hydrogen and carbon dioxide; a gas-purification device 7 for removing the carbon monoxide and other undesirable gas components; a plurality of joined, proton-conducting electrolyte-membrane (PEM) fuel cells 8, in which the hydrogen, as a fuel, is continuously supplied and carried away with air that is compressed by a compressor 14 and serves as an oxidation means; a cooling loop K for cooling the fuel cells 8; a line 16 that carries off the reaction water and discharges into the tank 3; and a line 18 that carries off the residual gas resulting from

the reaction in the fuel cell and is connected to a catalytic burner 5.

Fig. 1

#318505

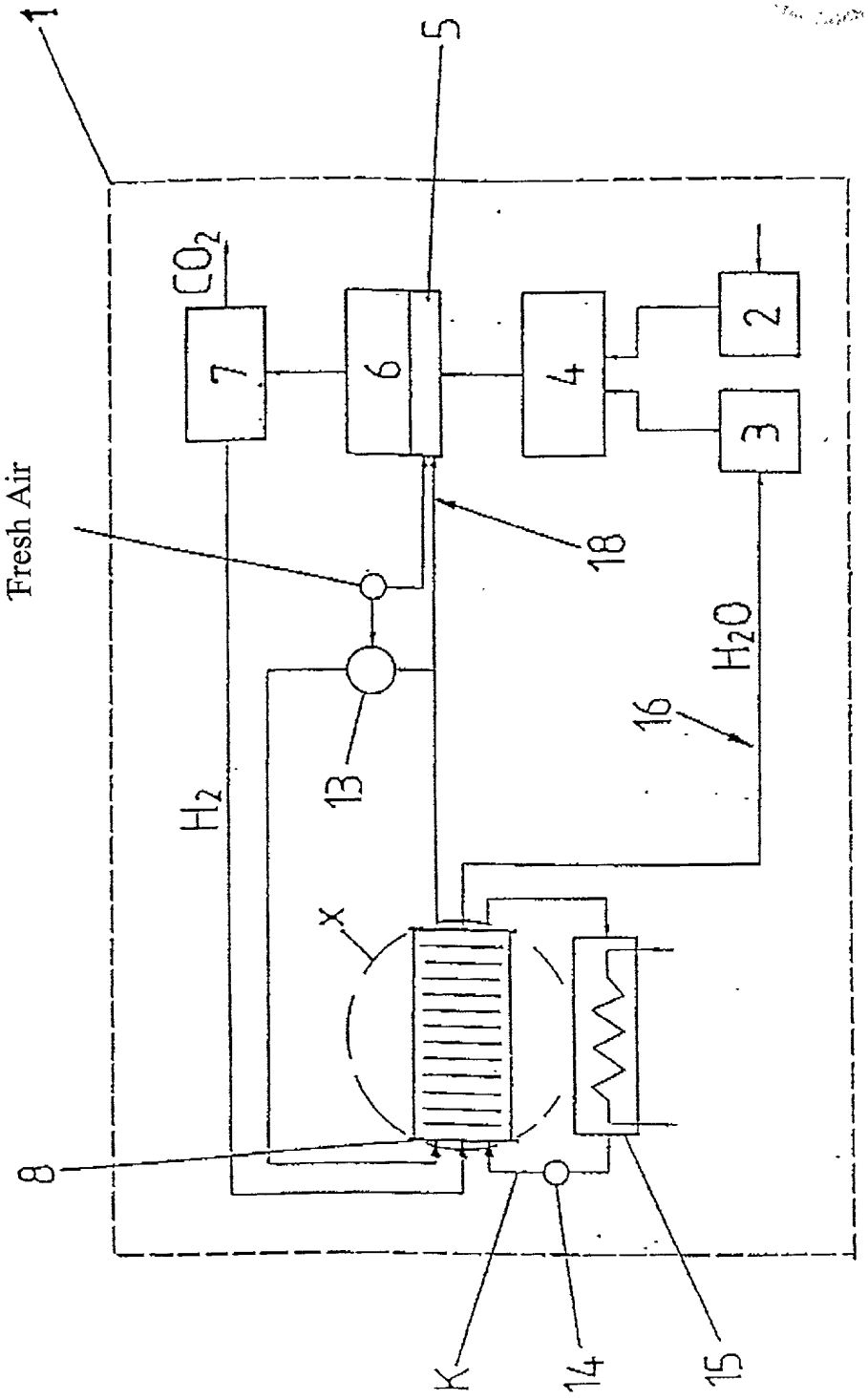

FIG. 1

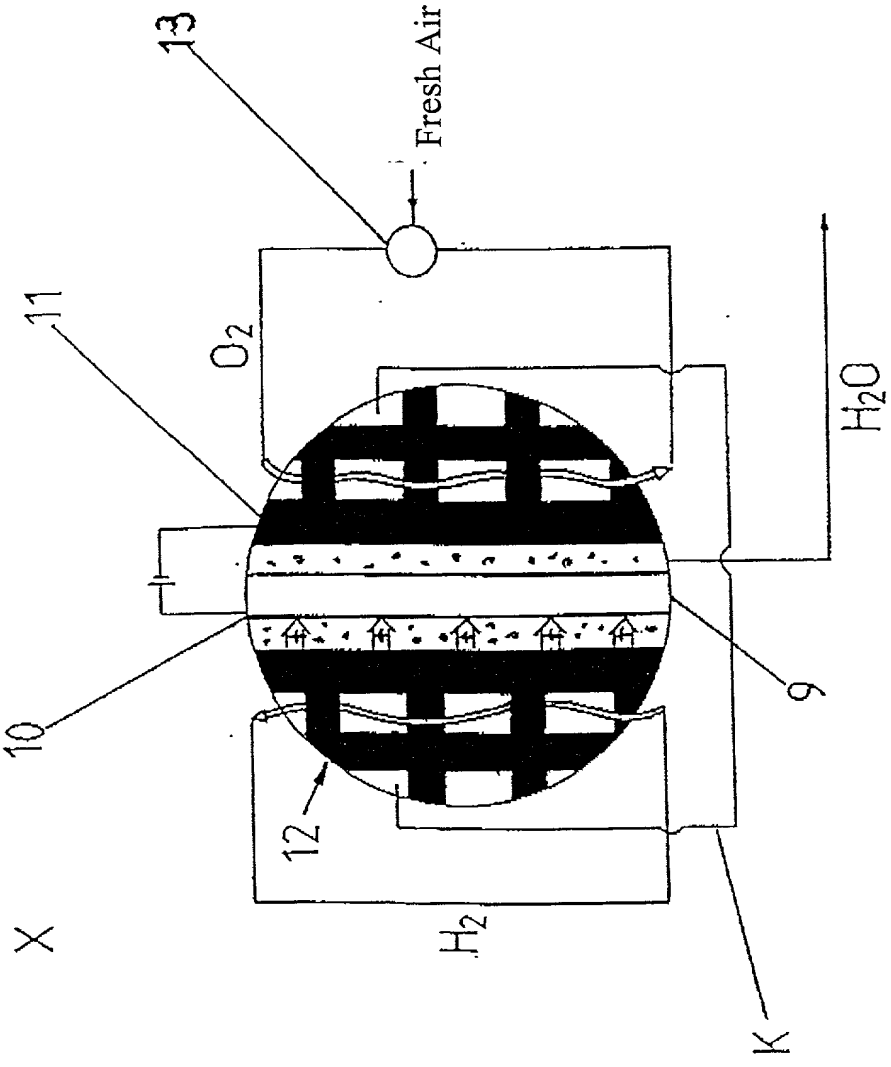

FIG. 2

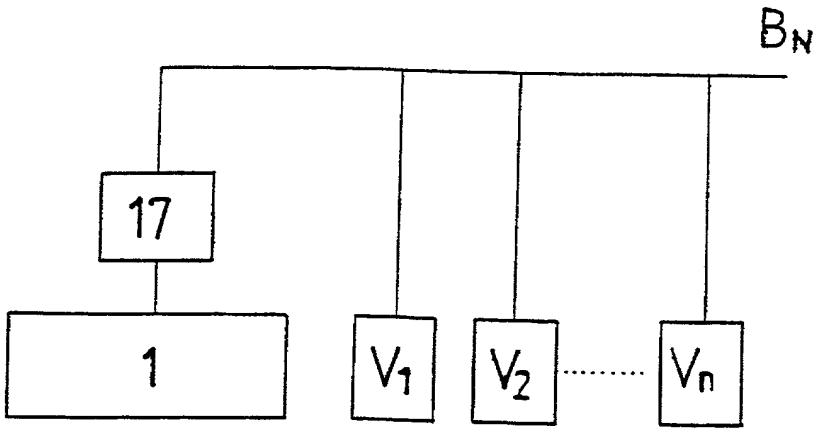

FIG. 3

DECLARATION FOR UNITED STATES PATENT APPLICATION
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

Attorney Docket: 31440-174181

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled DEVICE FOR SUPPLYING ELECTRICITY TO ACCESSORY DEVICES IN RAIL VEHICLES, the specification of which

[ ] is attached hereto.
[ ] was filed on _____, as Application Serial No. _____, Confirmation No. _____, and was amended on _____ [if applicable].
[X] was filed under the Patent Cooperation Treaty on October 26, 2000, Serial No. PCT/EP00/10559, United States of America being designated.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent, utility model, design or inventor's certificate listed below and have also identified below any foreign application(s) for patent, utility model, design or inventor's certificate having a filing date before that of the application(s) on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
Number	Country	Date Filed	Yes	No
199 54 031.4	Germany	October 29, 1999	X	

I hereby appoint the registered attorneys and agents of VENABLE associated with the following customer number to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

26694
PATENT TRADEMARK OFFICE

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The undersigned hereby authorizes the registered U.S. attorneys and agents identified herein to accept and follow instructions from the undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney or patent agent, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the registered U.S. attorneys and agents identified herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

100

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Continued on Page 2

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DECLARATION FOR UNITED STATES PATENT APPLICATION
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

200

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